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FLOOD INSURANCE STUDY

ORIGINAL

COMPLETED 27

TOWNSHIP OF PENNFIELD, MICHIGAN

CALHOUN COUNTY

APRIL 15, 1982

Federal Emergency Management Agency

COMMUNITY NUMBER - 260564

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Flood Boundary and Floodway Map

PUBLISHED SEPARATELY:

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FLOOD INSURANCE STUDY

TOWNSHIP OF PENNFIELD,
CALHOUN COUNTY, MICHIGAN

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the Township of Pennfield, Calhoun County, Michigan, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study will be used to convert the Township of Pennfield to the regular program of flood insurance by the Federal Emergency Management Agency (FEMA). Local and regional planners will use this study in their efforts to promote sound flood plain management.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than those on which these Federally-supported studies are based. These criteria take precedence over the minimum Federal criteria for purposes of regulating development in the flood plain, as set forth in the Code of Federal Regulations at 44 CFR, 60.3 (d). In such cases, however, it shall be understood that the state (or other jurisdictional agency) shall be able to explain these requirements and criteria.

1.2 Authority and Acknowledgements

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by Wade, Trim and Associates, Inc. for the Federal Emergency Management Agency, under Contract No. H-4802. This study was completed in April 1981.

1.3 Coordination

The limits of detailed and approximate studies in the Township of Pennfield were determined with community and Study Contractor consultation at a meeting on May 11, 1978. During the course of the study, flood elevations, flood boundaries and floodway delineations were reviewed with community officials and with officials of the Michigan Department of Natural Resources.

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The Michigan Department of Natural Resources, Hydrologic Studies Unit, Water Management Division provided information for this study. The U.S. Department of Agriculture, Soil Conservation Service (SCS), provided information on soils in the study area. The Township of Pennfield Clerk provided a Zoning Map and the Calhoun County Planning Commission provided a Land Use Map for the community. The Calhoun County Drainage Commission provided various maps for the study area.

The U.S. Geological Survey (USGS) and the U.S. Army Corps of Engineers (COE) were contacted, but could provide no information.

On December 1, 1981, the results of the work by the Study Contractor were reviewed and accepted at a final coordination meeting attended by representatives of the Study Contractor, the FEMA, and the community.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the Township of Pennfield, Calhoun County, Michigan. The area of study is shown on the Vicinity Map (Figure 1).

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development or proposed construction for the next five years, through April 1986.

Approximate methods of analysis were used to study those areas having a low development potential or minimal flood hazards as identified at the initiation of the study. The scope and methods of study were proposed to and agreed upon by FEMA and the Township of Pennfield.

The Battle Creek River was studied by detailed methods beginning at the Township of Pennfield/City of Battle Creek corporate boundary, located approximately 900 feet upstream of the Verona Dam, and ending at approximately 100 feet upstream of McAllister Road, a distance of about 5.0 miles.

Flooding of portions of Wanadoga Creek, Battle Creek, Mud Lake, Wolf Lake, Bear Lake, Dickinson Creek and St. Mary's Lake were studied by approximate methods.

2.2 Community Description

The Township of Pennfield is located in Calhoun County in southwestern Michigan. This community covers an area of approximately 35.5 square miles and is bordered on the north by the Township of Assyria in Barry

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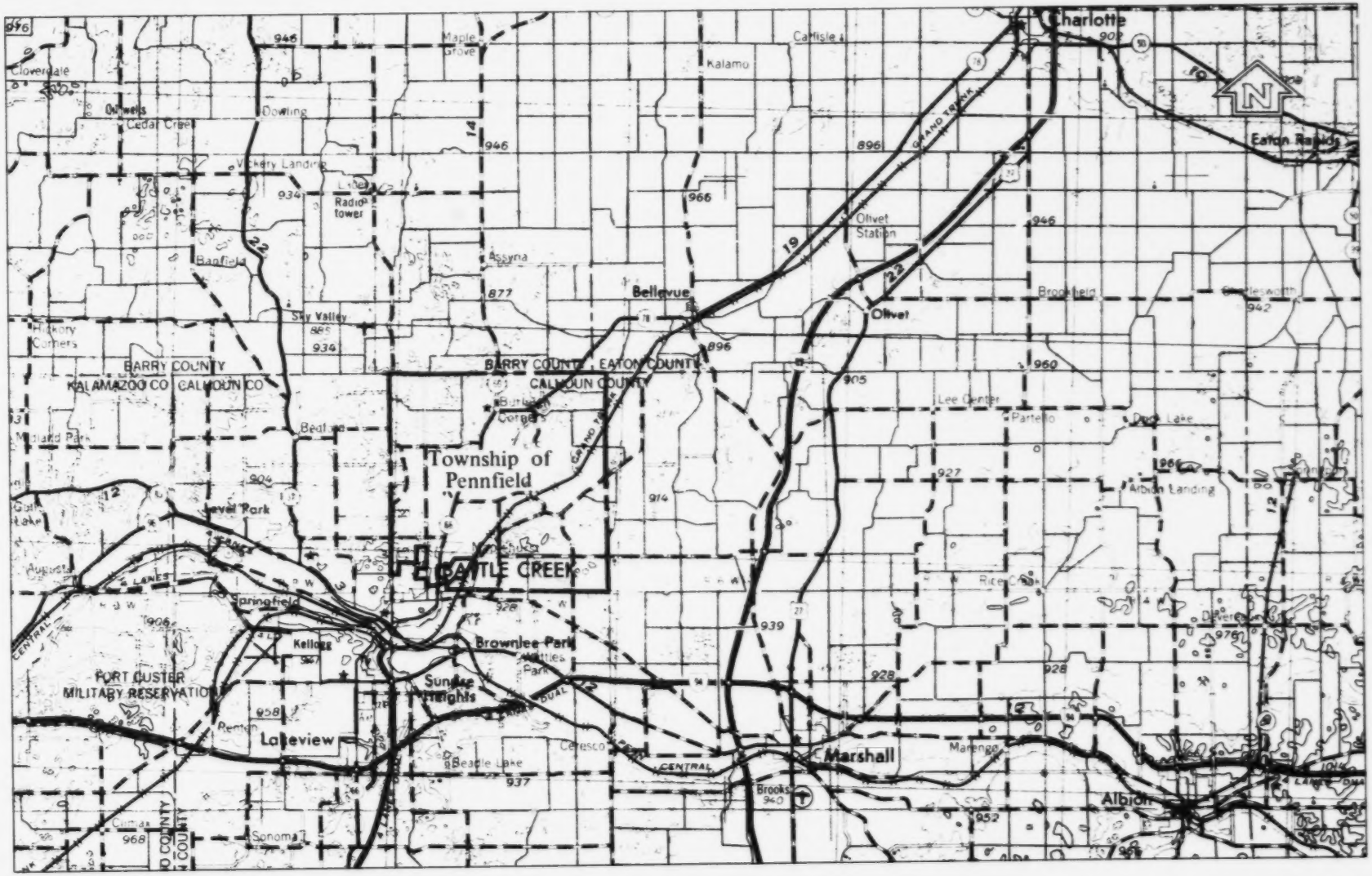

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF PENNFIELD, MI
(CALHOUN CO.)

APPROXIMATE SCALE

4 0 4 8 12 MILES

VICINITY MAP

County and the Township of Bellevue in Eaton County; on the south by the City of Battle Creek and the Township of Emmett; on the west by the City of Battle Creek and the Township of Bedford; and on the east by the Township of Convis. The 1970 U.S. Census indicates that the population was 8,219, whereas the 1980 U.S. Census indicates that the population was 8,743 (Reference 1).

While there are no major climatological stations located in the Pennfield study area, there is one located nearby in the City of Battle Creek (Reference 2). The climate of this area is influenced by Lake Michigan throughout most of the year. The mean annual temperature is 48 degrees Fahrenheit with an average frost-free season from approximately May 8 to October 9.

Precipitation is uniformly distributed throughout the year, being just slightly greater during the summer months than during the winter months. June, the month of greatest precipitation, averages approximately 3.8 inches while February, the month of least precipitation, averages approximately 1.8 inches. The annual average precipitation is approximately 34 inches. Snowfall in the area averages approximately 44 inches annually (Reference 3).

Soils within the Township of Pennfield vary from well drained having a moderate infiltration rate and coarse texture to soils with a high runoff potential having a slow infiltration rate and fine texture (Reference 4).

The Township of Pennfield is largely a rural, agricultural community characterized by farmlands, woods and open areas. Urbanization including commercial, industrial and residential development has concentrated in the southwestern quarter of the community. However, very little development has occurred within the flood plains within the community.

2.3 Principal Flood Problems

The history of flooding within the Township of Pennfield indicates that the main flooding season is during the winter and spring. Floods due to intense local thunderstorms have also been recorded during summer months and may occur at any time.

The worst flood of record occurred in 1975 with a storm discharge of 3,590 cubic feet per second (cfs) (Reference 5). The high water mark was recorded at 824.8 feet National Geodetic Vertical Datum (NGVD) for the Union Street Bridge in Battle Creek.

Combinations of weather and natural circumstances have served to create flooding problems within the township. Flooding may also be anticipated during periods of heavy rainfall, excessive snowmelt, or when other flooding situations are in evidence.

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2.4 Flood Protection Measures

No flood protection measures exist along or across the streams within the Township of Pennfield.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equalled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance premium rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 per cent chance, respectively, of being equalled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than one year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (one per cent chance of annual occurrence) in any 50-year period is about 40 per cent (four in ten), and for any 90-year period, the risk increases to about 60 per cent (six in ten). The analyses reported here reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for each flooding source studied in detail affecting the community.

Hydrologic analyses of the Battle Creek River were performed based upon 47 years of record (1931 to 1978) at the USGS gaging station (No. 04105000), located just upstream of Verona Dam in the City of Battle Creek (Reference 6). The log-Pearson Type III method was employed to analyze the peak flows (Reference 7). A hydrologic analysis of the Battle Creek River, performed for the City of Charlotte, Michigan Flood Insurance Study (Reference 8), was used to assist in the performance of this analysis. The drainage area proportion method was utilized to extrapolate the Battle Creek gage discharges to the Battle Creek River within the Township of Pennfield.

Peak discharges for the 10-, 50-, 100-, and 500-year floods of each flooding source studied in detail in the community are shown in Table 1.

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TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQ MILES)	PEAK DISCHARGE (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
BATTLE CREEK RIVER					
Battle Creek gage	241	2,360	3,600	4,200	5,800
Upstream of confluence of Wanadoga Creek	188	1,850	2,890	3,370	4,650

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the streams in the community were carried out to provide estimates of the elevations of the floods of the selected recurrence intervals along each flooding source studied in detail.

Cross sections utilized in the hydraulic analyses of the Battle Creek River were obtained from a field survey performed in April 1980. These cross sections were supplemented by an aerial survey (Reference 9) and USGS quadrangle maps at a scale of 1:24000 and 10-foot contour intervals (Reference 10). All bridges, dams and culverts were field checked to obtain elevation data and structural geometry.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles. For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map.

Roughness coefficients (Manning's "n"), for the Battle Creek River, were estimated by field inspection, quadrangle map information and survey photographs. Roughness values for the main channel range from 0.035 to 0.04; roughness values for the overbank areas vary between 0.08 and 0.12 for all floods.

These values are indicative of summer month conditions and are consistent with values recommended and used in engineering practice (Reference 11). Contraction and expansion coefficients ranged from 0.1 to 0.3 and 0.3 to 0.5, respectively. Expansion and contraction ratios used in effective flow modeling were 1:4 and 1:1, respectively, for all bridge sections and natural constrictions (Reference 12).

Starting water-surface elevations for the Battle Creek River, located upstream of Verona Dam, were taken from the City of Battle Creek Flood Insurance Study (Reference 13).

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The HEC-2 step-backwater computer program was used in developing water-surface profiles for the Battle Creek River (Reference 12). A 1975 flood high water mark (824.8 feet) for the Union Street Bridge was obtained from the City of Battle Creek engineering department. The 1975 storm discharge of 3,590 cubic feet per second (cfs) (Reference 5) was then applied to the HEC-2 computer model for the Battle Creek River and the Union Street high water mark was matched; therefore, the backwater model has been calibrated with an historical event.

The backwater analysis for the 1975 flood was run up to the Verona Dam gaging station, located 1.5 miles upstream of Union Street and tied into the rating curve for the dam (Reference 5).

A divided flow condition would occur along the Battle Creek River, dividing from the main stream about 850 feet downstream of McAllister Road and converging again about 10,000 feet downstream of McAllister Road, during the 100-year flood. A diversion analysis was performed to determine the distribution of flow between the main channel and the diversion area on the left overbank of the stream. Results of this analysis indicated that the diversion area would carry a small percentage of the total flow (5.5 per cent) and would not be considered as a portion of the floodway necessary to pass floodwater.

Flood profiles were drawn showing the computed water-surface elevations for floods of the selected recurrence intervals.

The hydraulic analyses for this study are based only on the effects of unobstructed flow. The flood elevations as shown on the profiles are, therefore, considered valid only if hydraulic structures, in general, remain unobstructed and if channel and overbank conditions remain essentially the same as ascertained during this study.

All elevations are referenced from National Geodetic Vertical Datum of 1929 (NGVD); elevation reference marks used in the study are shown on the maps.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages state and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by FEMA as the base flood for purposes of flood plain management measures. The 500-year flood is employed to

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indicate additional areas of flood risk in the community. For each stream studied in detail, the boundaries of the 100-year and the 500-year floods have been delineated using the elevations determined at each cross section; between cross sections the boundaries were interpolated using topographic maps at a scale of 1:24000 and 10-foot contour intervals (Reference 10).

For the streams studied by approximate methods, the boundary of the 100-year flood was developed from normal depth calculations, the topographic maps referenced above, and Flood Hazard Boundary Maps developed in the emergency phase of the flood insurance program (Reference 14).

The boundaries of the 100- and 500-year floods are shown on the Flood Boundary and Floodway Map. Small areas within the flood boundaries may lie above the flood elevations and, therefore, not be subject to flooding; owing to lack of detailed topographical information or to limitations of the map scale, such areas are not shown. In cases where the 100-year and the 500-year flood boundaries are close together, only the 100-year boundary has been shown.

4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity, increases the flood heights of streams, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment in order that the 100-year flood may be carried without substantial increases in flood heights. Minimum standards of FEMA limit such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced. In Michigan though, under Michigan Act 245, Public Acts of 1929, as amended by Act 167, Public Acts of 1968 (Reference 15), encroachment in the flood plain is limited to that which will cause only an insignificant increase in flood heights. Thus, at the recommendation of the Bureau of Water Management, a floodway having no more than a 0.1-foot surcharge has been delineated for this study.

The floodway for the Battle Creek River was computed on the basis of equal conveyance reduction from each side of the flood plain. The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed (Table 2). A portion of the Battle Creek River floodway is outside of the corporate limits.

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE
BATTLE CREEK RIVER							
A	17,090	364/160[2]	2928	1.4	829.6	829.6	0.0
B	18,390	234	2241	1.9	829.7	829.7	0.0
C	22,090	284/140[2]	2359	1.8	830.2	830.1	0.1
D	23,890	1261/1120[2]	7880	0.5	830.4	830.3	0.1
E	25,415	545	3876	1.1	830.5	830.4	0.1
F	26,340	1330	7673	0.5	830.6	830.5	0.1
G	28,240	1810	10,360	0.4	830.7	830.6	0.1
H	31,940	1317	7120	0.6	830.9	830.8	0.1
I	33,390	1158	6828	0.6	831.1	831.0	0.1
J	36,065	875	5168	0.8	831.3	831.2	0.1
K	38,465	1185	6636	0.6	831.6	831.5	0.1
L	42,565	496	2521	1.3	832.2	832.1	0.1
M	43,365	105	928	3.6	832.4	832.3	0.1
N	43,402	105	986	3.4	833.0	832.9	0.1

[1]FEET ABOVE CONFLUENCE WITH KALAMAZOO RIVER
[2]TOTAL WIDTH / WIDTH WITHIN CORPORATE LIMITS

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF PENNFIELD, MI
(CALHOUN CO.)

FLOODWAY DATA

BATTLE CREEK RIVER

As shown on the Flood Boundary and Floodway Map, the floodway widths were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 100-year flood are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 0.1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 2.

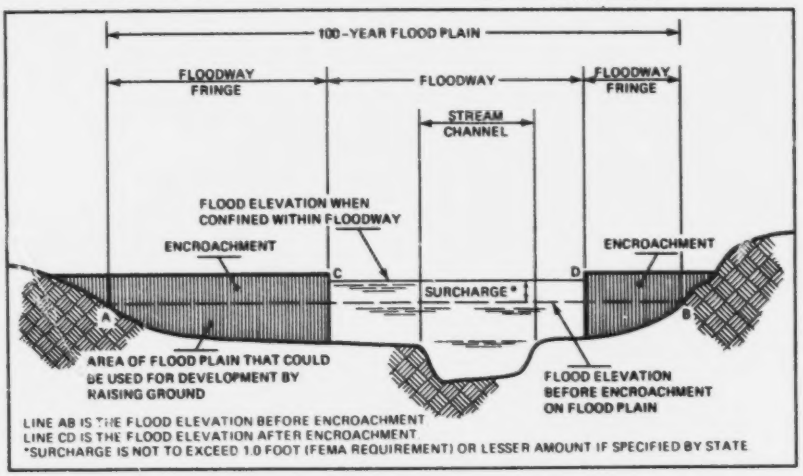
100-YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE

FIGURE 2 - Floodway Schematic

The floodways in this report are recommended to local agencies as minimum standards that can be adopted or that can be used as a basis for additional studies.

5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, FEMA has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors (FHF), and flood insurance zone designations for each flooding source affecting the Township of Pennfield.

5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference does not have a variation greater than that indicated in the following table for more than 20 per cent of the reach.

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Average Difference Between 10- and 100-year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the Township of Pennfield are shown on the Flood Profiles and are summarized in Table 3, "Flood Insurance Zone Data."

5.2 Flood Hazard Factors

The FHF is used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHFs are used to set actuarial insurance premium rate tables based on FHFs from 005 to 200.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest 0.5 foot, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, accuracy for the FHF is to the nearest foot.

5.3 Flood Insurance Zones

After the determination of reaches and their respective FHFs, the entire incorporated area of the Township of Pennfield was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

Zone A: Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations are shown or FHFs determined.

Zone A4: Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations are shown, and zones subdivided according to FHF.

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Zone B: Areas between the Special Flood Hazard Area and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; or areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.

Zone C: Areas of minimal flooding.

Table 3, "Flood Insurance Zone Data," summarizes the flood elevation differences, FHFs, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the Township of Pennfield is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by FEMA.

6.0 OTHER STUDIES

Flood Insurance Studies are currently in progress for the City of Battle Creek, the Township of Bedford and the Township of Emmett (References 13, 16 and 17). The results of the Pennfield study will match exactly these Flood Insurance Studies.

A Flood Hazard Boundary Map has been published for the community (Reference 14). The differences between the Flood Hazard Boundary Map and this study are justified due to the more detailed nature of this Flood Insurance Study.

This report either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the National Flood Insurance Program.

7.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, Federal Emergency Management Agency, 300 South Wacker Drive, (24th Floor), Chicago, Illinois 60606.

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FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
BATTLE CREEK RIVER							
REACH 1	0010	–2.0	–0.6	2.1	020	A4	VARIES–SEE MAP

[1]FLOOD INSURANCE RATE MAP PANEL
[2]WEIGHTED AVERAGE
[3]ROUNDED TO NEAREST FOOT

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF PENNFIELD, MI
(CALHOUN CO.)

FLOOD INSURANCE ZONE DATA

BATTLE CREEK RIVER

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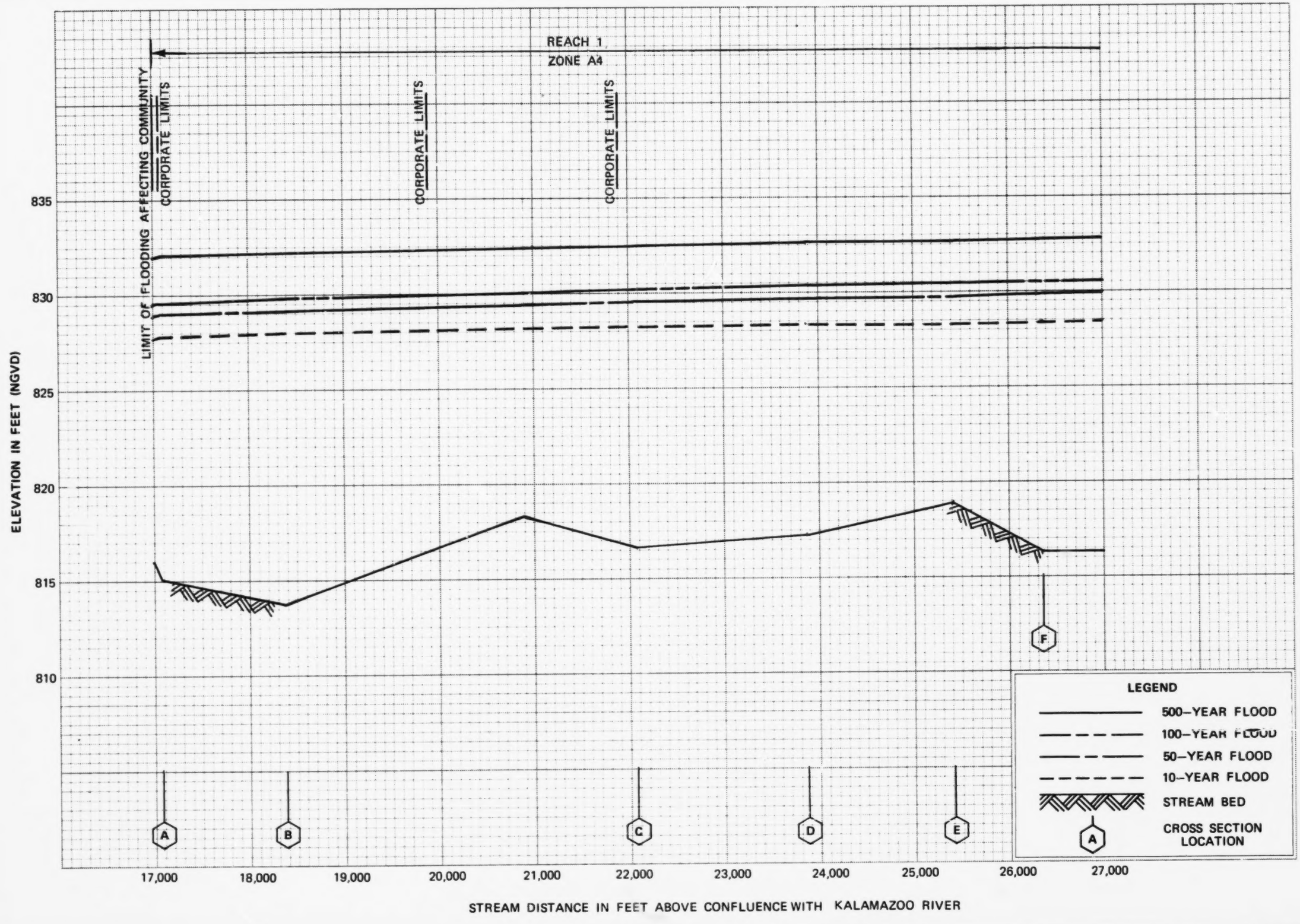

FLOOD PROFILES

BATTLE CREEK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF PENNFIELD, MI
(CALHOUN CO.)

01P

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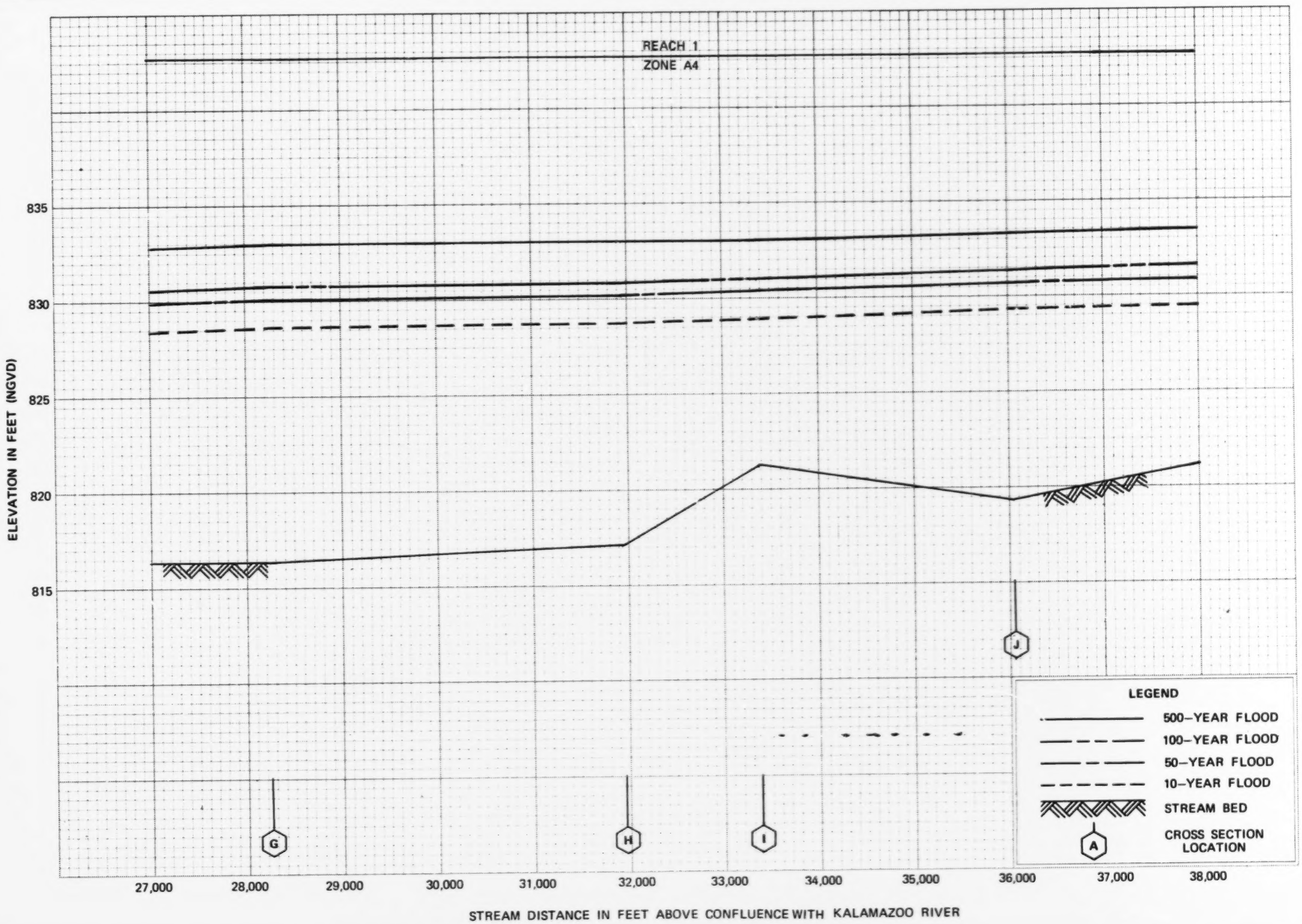

FLOOD PROFILES

BATTLE CREEK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF PENNFIELD, MI
(CALHOUN CO.)

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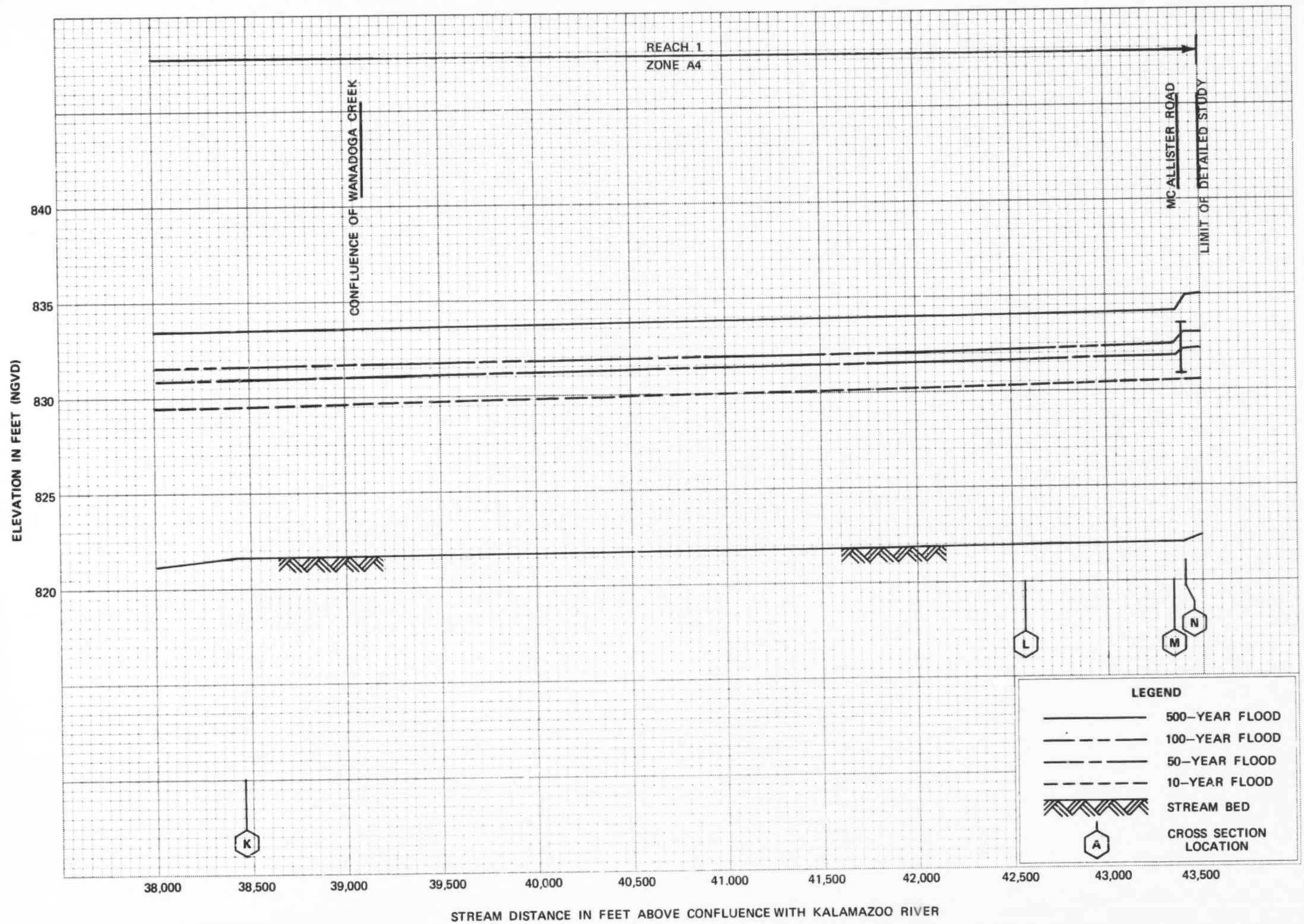

FLOOD PROFILES

BATTLE CREEK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF PENNFIELD, MI
(CALHOUN CO.)

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